Claims

[c1] 1. An electrode for rejuvenating a cooling passage within an airfoil, said electrode comprising:

a tip;

an end;

a conductive core extending between said tip and said end; and

an insulating coating disposed on said conductive core, said insulating coating exposing a plurality of conductive strips of said conductive core extending between said tip and said end, said insulating coating forming a plurality of insulating portions, and said insulating coating further exposing a plurality of spacer portions of said conductive core longitudinally positioned between said insulating portions,

wherein said insulating portions substantially span a distance between said tip and said end and are positioned between said conductive strips.

[c2] 2.The electrode of Claim 1, wherein said conductive strips are about 0.01 to about 0.06 cm in width, and said insulating portions are about 0.01 to about 0.06 cm in width.

[c3] 3.The electrode of Claim 2, wherein said conductive strips are about 0.02 to about 0.05 cm in width, and said insulating portions are about 0.02 to about 0.05 cm in width.

[c4] 4.The electrode of Claim 3, wherein said spacer portions are about 0.02 to about 0.05 cm in width, and said spacer portions are about 0.02 to about 0.05 cm in length.

[c5] 5.The electrode of Claim 2, wherein said spacer portions are about 0.01 to about 0.06 cm in width, and said spacer portions are about 0.01 to about 0.06 cm in length.

[c6] 6.The electrode of Claim 1, wherein the airfoil comprises a blade airfoil and the cooling passage comprises a radial cooling passage.

[c7] 7.The electrode of Claim 1, wherein the airfoil comprises a vane airfoil and the cooling passage comprises a central passage, and wherein said conductive core

conforms to a shape of the central passage.

[c8] 8.The electrode of Claim 1, wherein the airfoil comprises a vane airfoil having a central passage and a trailing edge, and the cooling passage extends between the central passage and the trailing edge.

[c9] 9.An electrochemical machining method for rejuvenating at least one cooling passage within an airfoil, said electrochemical machining method comprising:
preparing an inner surface of the cooling passage for electrochemical machining, including removing residue from the inner surface;
positioning an electrode in the cooling passage, the electrode comprising a conductive core and an insulating coating, the insulating coating exposing a plurality of exposed portions of the conductive core; and
machining a groove pattern on the inner surface of the cooling passage using the exposed portions of the conductive core by passing an electric current between the electrode and the airfoil while circulating an electrolyte solution through the cooling passage, said machining producing a rejuvenated cooling passage.

[c10] 10.The electrochemical machining method of Claim 9, wherein said preparation of the inner surface comprises performing a finishing process to remove non-conductive residue.

[c11] 11.The electrochemical machining method of Claim 10, wherein said preparation of the inner surface further comprises performing a chemical stripping process prior to performing the finishing process.

[c12] 12.The electrochemical machining method of Claim 11, wherein said chemical stripping process includes removing a vapor-phase aluminide coating from the inner surface of the cooling passage.

[c13] 13.The electrochemical machining method of Claim 10, wherein said finishing process comprises:
immersing the airfoil in an acidic solution;
rinsing the airfoil;
ultrasonically cleaning the airfoil; and

re-rinsing the airfoil.

[c14] 14.The electrochemical machining method of Claim 13, wherein said finishing process further comprises flushing the cooling passage after said re-rinsing.

[c15] 15.The electrochemical machining method of Claim 13, wherein the acidic solution comprises fluosilicic acid.

[c16] 16.The electrochemical machining method of Claim 15, wherein the fluosilicic acid comprises about zero percent (0%) to about seventy five percent (75%) of a mineral acid, the mineral acid comprising phosphoric acid, nitric acid, sulfuric acid, or combinations thereof.

[c17] 17.The electrochemical machining method of Claim 9, wherein the electrode further comprises a tip and an end, the conductive core extending between the tip and the end, wherein the exposed portions comprise conductive strips of the conductive core extending between the tip and the end of the electrode, wherein the insulating coating comprises a plurality of insulating portions which substantially extend between the tip and the end of the electrode, the insulating portions being positioned between the conductive strips to form an alternating pattern, wherein said machining of the groove pattern uses the alternating pattern, and wherein the groove pattern comprises a plurality of alternating grooves and fins.

[c18] 18.The electrochemical machining method of Claim 17, wherein the conductive strips and the insulating portions are configured so that said machining forms the grooves having dimensions of about 0.01 cm to about 0.06 cm in width and about 0.01 cm to about 0.06 cm in depth and forms the fins having dimensions of about 0.01 cm to about 0.06 cm in width and about 0.01 cm to about 0.06 cm in depth.

[c19] 19.The electrochemical machining method of Claim 17, wherein the airfoil comprises a blade airfoil, the cooling passage comprises a radial cooling hole, and the electrode is so dimensioned so as to have a diameter, which is within a range of about 0.008 to about 0.015 cm less that the diameter of the cooling passage.

[c20] 20.The electrode of Claim 17, wherein the airfoil comprises a vane airfoil having a central passage and a trailing edge, the cooling passage extends between the central passage and the trailing edge, and the electrode is so dimensioned so as to have a diameter, which is within a range of about 0.008 to about 0.015 cm less that the diameter of the cooling passage.

[c21] 21.The electrochemical machining method of Claim 17, wherein the insulating coating further exposes a plurality of spacer portions of the conductive core, the spacer portions being longitudinally positioned between the insulating portions, and wherein the groove pattern further includes a plurality of connectors, each connector being longitudinally positioned between two of the fins and connecting two of the grooves.

[c22] 22.The electrochemical machining method of Claim 21, wherein the conductive strips and the insulating portions are dimensioned so that said machining forms the grooves having dimensions of about 0.01 cm to about 0.06 cm in width and about 0.01 cm to about 0.06 cm in depth and forms the fins having dimensions of about 0.01 cm to about 0.06 cm in width and about 0.01 cm to about 0.06 cm in depth, and wherein the spacer portions are dimensioned so that the fins are spaced by about 0.01 cm to about 0.06 cm along a longitudinal direction.

[c23] 23.The electrochemical machining method of Claim 9, wherein the airfoil comprises a vane airfoil, the cooling passage comprises a central passage, and the conductive core conforms to a shape of the central passage.

[c24] 24.An electrochemical machining method for rejuvenating at least one cooling passage within an airfoil, said electrochemical machining method comprising: positioning an electrode in the cooling passage, the electrode comprising a tip, an end, a conductive core extending between the tip and the end, and an insulating coating disposed on the conductive core, the insulating coating exposing a plurality of conductive strips of the conductive core extending between the tip and the end, the insulating coating forming a plurality of insulating portions substantially spanning a distance between the tip and the end and positioned between the conductive strips, and the insulating coating further exposing a plurality of spacer portions of the conductive core

0.06 cm in width, about 0.01 to about 0.06 cm in depth, and about 0.01 to about 0.06 cm in length.

[c30] 30.The airfoil of Claim 25, wherein said airfoil is a blade airfoil, wherein said tip includes at least one exit hole, wherein said cooling passage is a radial cooling passage extending through said body between said tip and said root, and wherein said exit hole is connected to said radial cooling passage and is configured to vent coolant from said airfoil after the coolant flows through said radial cooling passage.

[c31] 31.The airfoil of Claim 25, wherein said airfoil is a turbine vane airfoil having a trailing edge, wherein said cooling passage is a discharge hole formed in said trailing edge and configured to vent coolant from said airfoil.

[c32] 32.The airfoil of Claim 25, wherein said cooling passage is a rejuvenated cooling passage.